A Novel Drag-Free Design for a Geostationary Gravitational Wave

Completed Technology Project (2013 - 2016)

Project Introduction

The opportunity exists for flying and operating a geostationary gravitational wave interferometer that relies on three communication satellites (comsats). Since current drag-free designs can't provide the level of "free-fall" onboard these spacecraft because of their large size and mass, in collaboration with Stanford University we have developed a novel drag-free system that operates without the need of micro-newton (mN) thrusters. The proposed system could also be used onboard suitably designed spacecraft for future planned gravitational wave missions or for other space-based precision gravity experiments.

Given the large volume and additional mass available for scientific use on planned commercial geostationary platforms, we have conceived an alternative drag-free design, which we have named "Two-Stage Drag-free". It can be regarded as a modification of the Modular Gravitational Reference Sensor (MGRS) design developed at Stanford University during the past decade. Our two-stage drag-free system works in the following way. A rigid structure containing the MGRS is free-floating within the enclosure cap added to a comsat nadir deck. The free-floating spherical proof mass location, relative to the rigid structure hosting it, is measured through laser metrology; the position of the rigid structure within the enclosing cap is measured instead by a network of sensors. The sensors data is passed on to a set of cold-gas thrusters that act on the comsat to maintain its position relative to the rigid structure to within a few centimeters, while at the same time both measurements are used by a set of actuators that constantly maintain the rigid structure centered on the spherical proof mass. In our two-stage drag-free design the actuators rely on the comsat mass to react against in order to center the rigid structure on the proof-mass, thereby performing the equivalent operation of the μN thrusters in the traditional drag-free design.

Anticipated Benefits

Enables new mission concepts

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Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

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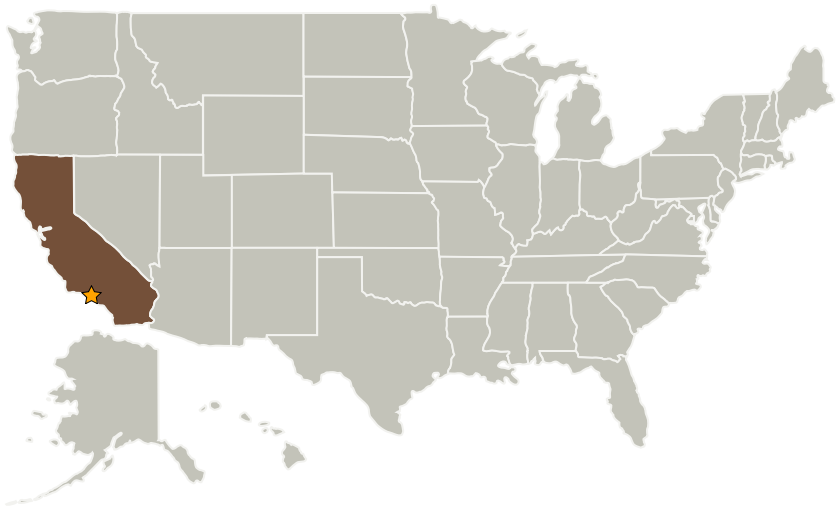
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Management

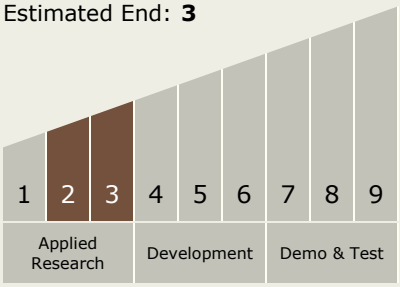
Program Manager:
Fred Y Hadaegh

Project Manager:
Jonas Zmuidzinas

Principal Investigator:
Massimo Tinto

Technology Maturity (TRL)

Start: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.3 Distributed Aperture